PHOSPHORUS MANAGEMENT

Plant Availability of Phosphorus in Swine Slurry and Cattle Feedlot Manure

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ABSTRACT

To utilize manure P for crop production, P release and plant availability needs to be quantified. An incubation study was conducted to determine P availability from swine (*Sus scrofa*) and cattle (*Bos taurus*) feedlot manure in three soils. Treatments for each manure included temperature (11, 18, 25, and 32°C), water regime [constant 60% water-filled pore space (WFPS) vs. four dry-down cycles of 60 to 30% WFPS], time, and soils (Catlin silt loam, Sharpsburg silty clay loam, and Valentine fine sand). In another study, synthetic P fertilizer was used to determine the fraction of P that becomes unavailable with time to compare with manure P. Time, soil, and manure application were factors that influenced soil test P and water-soluble P during incubation. At the low synthetic P fertilizer rate of 6 μg g^{-1}, about 12 kg P ha^{-1}, none of the applied P remained available in the Catlin soil while about one-third remained plant available in the Sharpsburg soil and two-thirds in the Valentine soil. At the high P rate, 68 mg kg^{-1}, 38 to 83% of fertilizer P remained available in the three soils. Phosphorus availability was 60 to 100% of applied cattle manure P and 52 to 100% of swine slurry P in the three soils. Phosphorus availability in the Sharpsburg soil was 100% of P in both manure types. Phosphorus availability from manure is high, and manure can be used similar to inorganic P fertilizer in soils where P-based application is made in areas susceptible to P loss in runoff. In P-deficient soils, a P availability of 70% should be used.

M ANURE CONTAINS significant amounts of P that can be utilized for crop production. Manure is usually applied to provide N needs of a growing crop. However, because of concerns about surface water pollution with P and the subsequent eutrophication, P-based manure application is becoming more common in a number of states (Weld et al., 2002; Sharpley et al., 2003). The USDA and USEPA (1999) jointly issued the Unified Strategy for Animal Feeding Operations in which P-based management approaches were emphasized for sites vulnerable to P loss. The final Confined Animal Feeding Operation's rule was registered on 12 Feb. 2003. Eghball and Power (1999) found that P-based manure or compost application resulted in soil test P levels similar to the original soil P level after 4 yr of application, but N-based application resulted in significant P buildup of up to 265 mg kg^{-1} in the soil. This is because N/P ratios of most manure types are narrower (e.g., 3:1) than the N/P uptake ratios of most crops (e.g., 6:1 for corn). Therefore, N-based manure application provides P rates

that are in excess of the crop P removal. Excess P can accumulate in the soil and can increase P in runoff. Pote et al. (1996, 1999) found increased P loss in runoff as the soil P test increased. Eghball et al. (2002b) showed that soil test P was not a significant factor when manure was applied shortly before rainfall; however, P loss in runoff was related to soil test P when manure application was made a year earlier.

To provide P needs of a crop, the amount of P mineralized following manure application needs to be determined. Phosphorus in manure is in various forms but is mostly inorganic (Sharpley and Moyer, 2000; Eghball, 2003), indicating that P availability following application should be high if the inorganic P converts to plant available form after application. Mineralization of organic P in the soil is catalyzed by various enzymes, including phytase (He and Honeycutt, 2001). Water-soluble P (WSP) was 19% of swine manure P (Sharpley and Moyer, 2000) and <8% of beef cattle feedlot manure P (Eghball and Gilley, 1999). Kleinman et al. (2002) showed that dissolved P in runoff was highly related with the WSP content of manure. Based on the soil test P changes and plant P uptake 1 yr after application, P availability in the first year after application was 85% for beef cattle feedlot manure and 73% for composted feedlot manure (Eghball et al., 2002a). Slightly lower P availability from composted than noncomposted manure indicated chemical reaction of P during composting that involved turning and mixing caused P to become less plant available. Motavalli et al. (1989) found that P availability from injected dairy manure ranged from 12 to 89% based on P uptake. The low P availability in this study was due to a small crop P uptake response from applied manure P. In a field study, Wen et al. (1997) found that 69% of composted manure P was plant available. Ebeling et al. (2003) found that composition of the P source added influenced soil test P.

Soil and environmental factors influence manure P and N mineralization and availability. Soil and manure N mineralization increases with increasing temperature under conditions found in agricultural soils (Cassman and Munns, 1980; Eghball, 2000). Mineralization is greatest when soil moisture is near field capacity and declines with soil drying (Cassman and Munns, 1980). The variables that influence P release and availability need to be evaluated so that manure P availability in the soil can be estimated. The objective of this study was to evaluate the effects of temperature and soil water

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Abbreviations: BKP, Bray and Kurtz no. 1 phosphorus; T0, soil samples taken when the experiment started; T1–T4, sampling cycles when the soil in the varying water content treatment was reduced from 60 to 30%; WFPS, water-filled pore space; WSP, water-soluble phosphorus.

regime on P release and availability from cattle feedlot manure and swine slurry in three different soils.

MATERIALS AND METHODS

Experiments involving swine slurry and beef cattle feedlot manure were conducted at separate times. For each manure type (swine and beef cattle feedlot), variables included were soil type (three soils ranging from a silty clay loam to a fine sand), P source (manure and no-P control), temperature (soils incubated at 11, 18, 25, and 32°C for beef manure and 18, 25, and 32°C for swine slurry), and soil water regime (soil moisture maintained at 60% WFPS or soil cycled through four wet–dry cycles from 60 to 30% WFPS). Manure was applied at a rate equivalent to 350 kg N ha^{-1}. Phosphorus application rate was 67 kg P ha^{-1} for the cattle feedlot manure and 116 kg P ha^{-1} for the swine slurry. For each manure type, the experimental design was a split-split plot in a completely randomized design with three replications. Incubation temperature was the main plot, soil was the subplot, and manure or no manure and water regime combinations were randomly assigned within each soil as the sub-subplots.

Three soils having different textures were used in this study. Selected properties of Catlin loam (fine-silty, mixed, superactive, mesic Oxyaquic Arguidolls), Sharpsburg silty clay loam (fine, smectitic, mesic Typic Argiudolls), and Valentine fine sand (mixed, mesic Typic Ustipsamments) are given in Table 1.

Beef cattle feedlot manure and swine waste (feces and urine) were collected during the spring of 2001. Manure was mixed and a subsample collected and stored at 4°C for use in this study. Cattle feedlot manure contained 26.2 g total N kg^{-1}, 1.14 g NH$_4$–N kg^{-1}, and 5.13 g total P kg^{-1}, both on dry weight basis, and had a water content of 691 g kg^{-1}. Swine slurry contained 4.4 g N kg^{-1} and 1.45 g P kg^{-1} both on as-is basis (4.6% dry matter) with ammonium accounting for 64% of total N. Manure total N and total P were analyzed based on the methods described by Padmore (1990) and Johnson and Ulrich (1959), respectively.

Soil (250 g) was placed into 2-L jars. Manure was added to jars in the manure-amended treatments and thoroughly mixed with the soil. Distilled water was added to all jars to wet the soil to 60% WFPS. The soil in each jar was then packed to the bulk densities usually observed for the soils in the field condition (1.2 Mg m^{-3} for the Catlin soil, 1.3 Mg m^{-3} for the Sharpsburg soil, and 1.4 Mg m^{-3} for the Valentine soil). A lid having a 1.2-cm-diam. hole (to allow aeration and evaporation) was placed on each jar. Jars were placed in the appropriate incubator and maintained at the treatment temperature. Jars were weighed every 2 or 3 d. Distilled water was added as needed to jars in the constant moisture regime to maintain 60% WFPS. Jars in the wet–dry regime were allowed to dry to 30% WFPS before distilled water was added to return the soil moisture to 60% WFPS. The length of time to reach 30% WFPS differed for each temperature.

Soil in each jar was sampled on the day the experiment was initiated (T0) and at the end of each drying cycle (T1–T4) for a total of five samplings. Each soil was dried at a different rate, and drying times varied with temperature. Therefore, all jars containing a given soil at a particular temperature were sampled when the jars containing that soil in the varying moisture treatment reached 30% WFPS. When the soil in the varying moisture treatment dried to 30% WFPS, soil in all jars for that soil at that temperature was wetted to 60% WFPS and allowed to equilibrate for 4 h. Approximately 10 g of moist soil was removed with a coring device. Five grams of soil was used for moisture determination, and 5 g was used

Table 1. Selected properties for the soils used.

Soil	C	Sand	Silt	Clay	EC†	pH†
		g kg^{-1}			d S m^{-1}	
Catlin	28.6	160	640	200	0.44	6.8
Sharpsburg	18.0	80	620	300	0.43	6.2
Valentine	9.0	940	30	30	0.47	5.3

† Electrical conductivity (EC) and pH were measured on 1:1 water/soil ratio.

to determine P concentration. Immediately after sampling, jars were returned to the appropriate incubator.

Some of the released P is expected to be adsorbed by the soil with time. In another laboratory incubation study, synthetic P fertilizer was used to determine the quantity of P that becomes unavailable with time and compare manure plant availability with synthetic P fertilizer (100% plant available). Since >70% of manure P is inorganic, the assumption was that fixation of P from fertilizer and manure would not be significantly different. Phosphorus fertilizer (K$_2$HPO$_4$) was applied to soils in twenty-seven 2-L jars (nine jars per soil) at rates of 0, 6, and 68 mg P kg^{-1} soil. The soils were incubated at 25°C and constant water content of 60% WFPS. The soils were sampled approximately every 2 wk. The percentages of P fertilizer remaining plant available were used to approximate the P availability from swine and cattle manure, assuming similar amounts of P becoming unavailable from the manure treatments as from the 68 mg P kg^{-1} fertilizer rate. In this calculation, the increase in soil test P (BKP; Bray and Kurtz, 1945) due to manure application minus the increase in soil P for the no-treatment control (to remove the amount of soil P mineralized) was divided by the fraction of fertilizer P that was plant available for each manure type and sampling time to determine manure P availability. Since no significant effect ($P > 0.05$) of temperature and water regime was observed for BKP for either manure type, calculations were made across all temperatures and the two water regimes for each manure type.

Soil BKP was determined for all samples. Water-soluble P was determined on samples from times T2 and T4 for the cattle feedlot manure and for times T0, T2, and T4 for the swine slurry by shaking 1 g of soil with 10 mL of distilled water for 5 min. The soil–water mixture was then filtered, and the solution was analyzed for P using the method given by Murphy and Riley (1962). Phosphorus release was determined by the increase in soil test P with time of incubation.

Results are presented separately for each manure type since swine slurry did not have the 11°C temperature treatment, and each manure type was incubated at a different time. Analysis of variance was performed for each manure type using the Mixed Models procedure of SAS (Littell et al., 1996). In these analyses, sampling times were considered as repeated measures. A probability level ≤ 0.05 was considered significant.

RESULTS AND DISCUSSION
Soil Phosphorus Level

Swine Slurry

Incubation time, soil, and manure application influenced soil BKP and WSP concentrations (Table 2). The BKP level remained the same for T0 to T2 but decreased for T3 and T4, suggesting adsorption of P by soil constituents with time of contact (Table 3). Soil WSP concentration change with time was in the order T0 > T2 = T4. As expected, swine slurry application increased both

Table 2. Analysis of variance for the effects of time, temperature, soil, manure application, and water regime on Bray and Kurtz no. 1 soil P test (BKP) and water-soluble P (WSP) during laboratory incubation.

| | Swine slurry | | | | Beef cattle manure | | | |
| | BKP | | WSP | | BKP | | WSP | |
Variable†	df	$P > F$	df	$P > F$	df	$P > F$	df	$P > F$
Time (T)	4	0.0004	2	0.0001	4	0.0001	1	0.0001
Temperature (TM)	2	0.4929	2	0.4688	3	0.5084	3	0.2088
T × TM	8	0.7835	4	0.9954	12	0.0016	3	0.1744
Soil (S)	2	0.0001	2	0.0001	2	0.0001	2	0.0001
T × S	8	0.0001	4	0.0001	8	0.0001	2	0.3805
TM × S	4	0.0021	4	0.9724	6	0.2183	6	0.0224
T × TM × S	16	0.0028	8	0.0608	24	0.0002	6	0.0224
Manure (M)	1	0.0001	1	0.0001	1	0.0001	1	0.0001
T × M	4	0.0773	2	0.0001	4	0.2969	1	0.1444
S × M	2	0.0001	2	0.0001	2	0.7335	2	0.0093
T × S × M	8	0.2867	4	0.0001	8	0.4918	2	0.8619
TM × S × M	4	0.0895	4	0.6938	6	0.4222	6	0.0291
Water (W)	1	0.2329	1	0.2983	1	0.0635	1	0.1446
M × W	1	0.3991	1	0.2279	1	0.0436	1	0.2431
TM × S × M × W	4	0.0089	4	0.4007	6	0.1369	6	0.0406

† Only the main effects and those interactions that have a probability ≤ 0.05 level for at least one parameter are shown.

BKP and WSP concentrations in the soil (Table 3). Water regime did not significantly influence soil BKP and WSP concentrations, indicating that the range of soil water content (30 and 60% WFPS) was probably not wide enough to make a significant difference in P release when swine slurry was applied. Also, incubation temperature was not a significant factor in P release (Table 2). However, temperature interacted with soil,

Table 3. Least square means for the main effects of time, temperature, soil, manure, and water regime on Bray and Kurtz no. 1 P (BKP) and water-soluble P (WSP) in soil receiving beef cattle feedlot and swine slurry.

| | Swine slurry | | Beef cattle manure | |
Variable	BKP	WSP	BKP	WSP
		mg kg^{-1}		
Time†				
0	63.1	5.92	43.8	–‡
1	62.5	–	55.2	–
2	60.9	4.62	67.8	6.25
3	60.4	–	60.0	–
4	58.2	4.64	63.6	4.75
LSD$_{0.05}$	2.4	0.46	4.1	0.72
Soil				
Catlin	126.3	6.54	128.3	8.28
Sharpsburg	30.9	2.27	26.9	3.63
Valentine	25.8	6.36	19.1	4.59
LSD$_{0.05}$	2.8	0.49	3.7	1.07
Temperature (°C)				
11	not used	not used	57.4	5.93
18	59.6	5.08	59.0	5.69
25	61.8	4.88	56.6	4.58
32	61.6	5.22	59.4	5.79
LSD$_{0.05}$	NS§	NS	NS	NS
Manure treatment				
Manure	74.1	7.16	65.2	6.92
No manure	47.9	2.96	51.0	4.08
LSD$_{0.05}$	1.9	0.36	2.5	0.81
Water regime¶				
Constant	61.6	4.96	59.3	5.80
Varying	60.4	5.15	56.9	5.20
LSD$_{0.05}$	NS	NS	NS	NS

† Time 0 is when soil samples were taken on the day the experiment started, and 1 to 4 are sampling cycles when the soil in the varying water content treatment was reduced from 60 to 30% water-filled pore space.
‡ Was not determined.
§ NS indicates an LSD with probability level > 0.05.
¶ Constant is when soil water content was kept at 60% water-filled pore space, and varying is when water content was allowed to fluctuate between 30 and 60% water-filled pore space.

manure, and water regime (Table 2). The soil BKP level was similar between constant and variable water treatment for the soils that did not receive manure at all temperatures (Fig. 1). However, soil BKP decreased with increasing temperature for Sharpsburg soil under constant water regime. The manure × soil interaction indicated that the soil BKP increase due to manure application was greatest for the Valentine soil and was least for the Catlin soil (Fig. 2), reflecting less P adsorption in the Valentine fine sand soil. The increase in soil BKP concentration due to manure application was least for the Catlin soil even though it had the highest initial soil test P level (Table 4), indicating great P adsorption capacity in this soil. Water-soluble P increase due to manure application was also the highest for the Valentine soil, but the differences between manure and no-manure treatments became smaller with time of incubation, reflecting P adsorption with time for all three soils (Fig. 3). There was no biologically meaningful trend in the soil × time interaction for BKP (data not shown).

Beef Cattle Feedlot Manure

Similar to swine slurry, incubation time, soil, and manure application influenced BKP and WSP concentrations in the soil that received beef cattle feedlot manure (Table 2). The BKP values increased with incubation time up to T2 after which the soil P level decreased (Table 3). Similar to BKP, soil WSP concentration decreased from T2 to T4, suggesting that soil adsorption reduced the WSP level with time (Table 3). As expected, manure application increased soil BKP and WSP concentrations. Constant water regime resulted in higher soil BKP concentration than variable water regime, but the difference was significant at the 0.06 level (Table 2). However, manure × water regime interaction (Table 2) indicated that there was a significant difference between constant and variable water regime for the manure treatment (68 vs. 63 mg BKP kg^{-1}, respectively) while the no-manure control was unaffected by water regime (51 mg kg^{-1} for both). This indicated that P release from cattle manure would be less under typical field
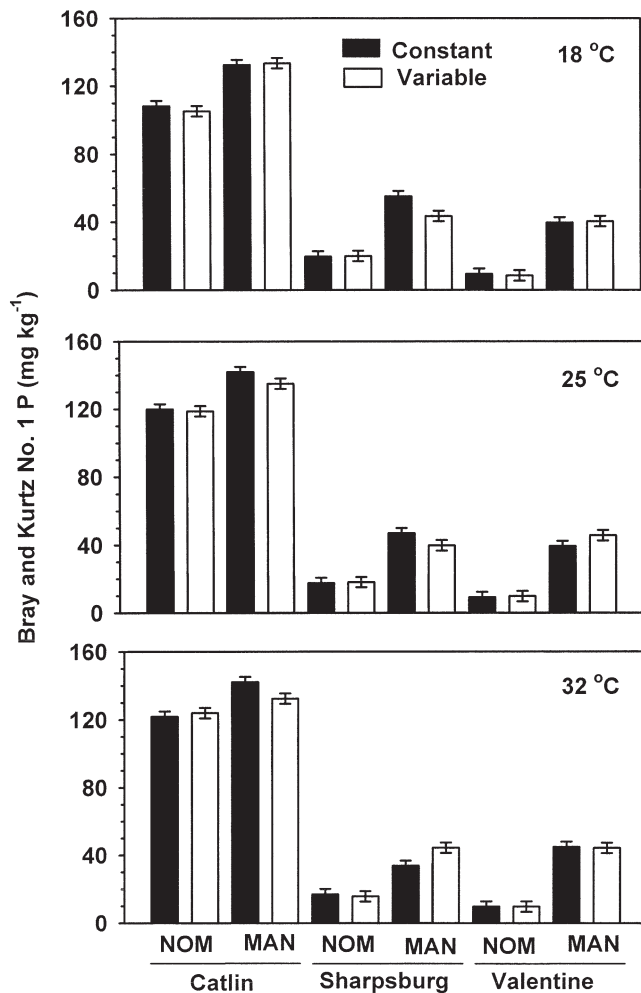
Fig. 1. Soil × temperature × manure × water regime interaction means averaged across sampling times. Water regimes were constant (60% water-filled pore space, WFPS) or variable (dry down from 60 to 30% WFPS). NOM indicates no manure, and MAN indicates swine manure application.

Fig. 2. Phosphorus levels in three soils incubated with either swine slurry or no manure averaged across sampling times and water regimes.

conditions where soil undergoes variable water content. Temperature did not influence BKP or WSP concentrations in the soil. However, temperature interacted with time for BKP level (Table 1 and Fig. 4a). The soil BKP concentrations increased with time for all temperatures up to T2 (except 11°C), after which all temperatures resulted in similar soil BKP level. This once again indicated nonimportance of temperature level on P release after some contact time with the soil (Fig. 4a). This is
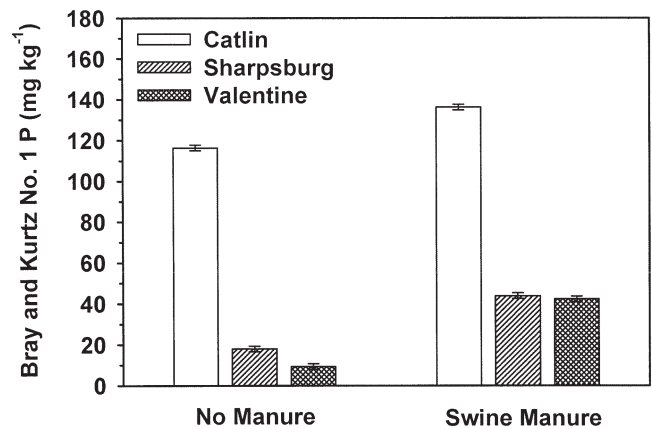
probably because the increase in BKP is a function of a combination of P release from inorganic manure P pool and biological mineralization of manure organic P. The time × soil interaction for BKP pointed to differences among soils for P release with time (Fig. 4b). The BKP level increased with time up to T2 in the Catlin soil but remained constant for the Valentine soil. In the Sharpsburg soil, there was an increase in soil BKP level from T0 to T2 beyond which the BKP level decreased (Fig. 4b). The increase in soil test P with time in the Catlin soil was probably the result of higher C concentration in this soil (Table 1) and the subsequent increased mineralization. The temperature × time × soil interaction for BKP was mainly caused by a high value for the Catlin soil at T1 and 32°C (data not shown).

Water-soluble P decreased from 18°C to 25 and 32°C incubation temperatures for Catlin and Sharpsburg soils but increased for the Valentine soil (Fig. 5a). This indicated that higher temperature resulted in increased adsorption of P in the heavier-textured soils (Catlin and Sharpsburg) but increased P release in the sandy Valentine soil. It seems that the limited adsorption sites in this sandy soil became saturated, and hence released P remained in solution and concentration continued to increase with time due to P mineralization. Water-soluble P increases due to manure application were also higher for the Valentine than other soils (Fig. 5b). The significant temperature × soil × manure × water regime for WSP in the beef cattle manure study was caused by a significant increase in the manure treatment receiving

Table 4. The percentages of applied synthetic P fertilizer remaining plant available in three soils following incubation at two application rates.

Soil	Initial soil P	P rate	T0†	T1	T2	T3	T4
	mg kg⁻¹				%		
Catlin	119.1	6	45 ± 22‡	0 ± 68	0 ± 64	0 ± 41	4 ± 45
Catlin	119.1	68	49 ± 7	90 ± 9	80 ± 4	65 ± 11	61 ± 5
Sharpsburg	16.3	6	40 ± 10	44 ± 1	29 ± 4	25 ± 8	34 ± 6
Sharpsburg	16.3	68	55 ± 12	68 ± 9	48 ± 2	52 ± 4	38 ± 4
Valentine	9.3	6	71 ± 4	66 ± 4	68 ± 8	64 ± 2	73 ± 11
Valentine	9.3	68	75 ± 2	83 ± 1	82 ± 5	74 ± 1	79 ± 3

† Time T0 is when soil samples were taken on the day the experiment started, and T1 to T4 are sampling about every 2 wk.
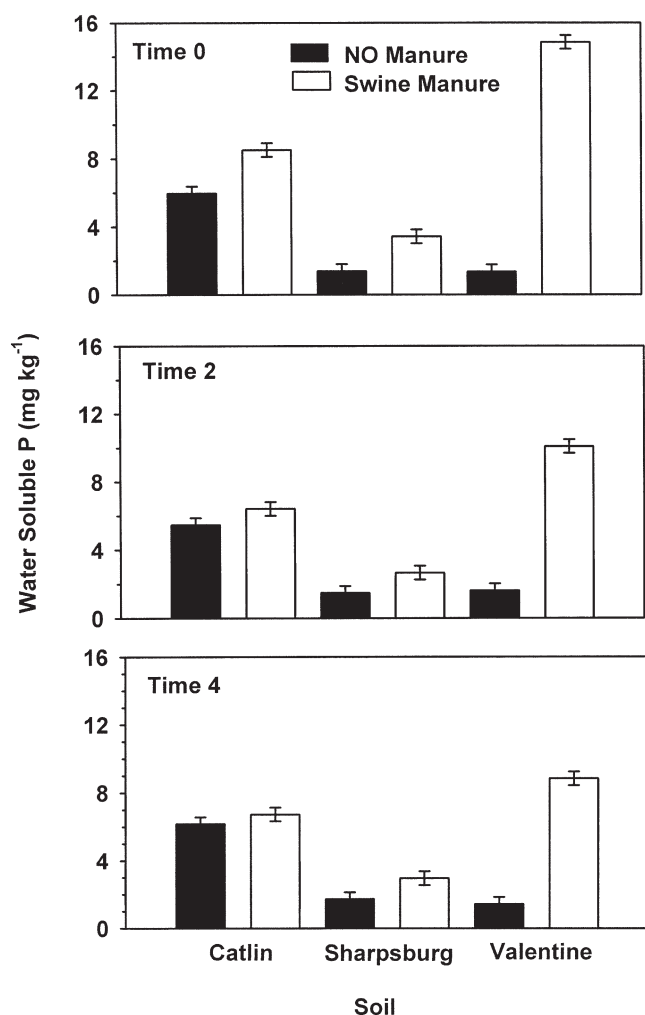‡ The values after ± are standard errors.

Fig. 3. Water-soluble P, averaged across water regime, in three soils incubated with either swine slurry or no manure and sampled at different times. Time T0 is when soil samples were taken on the day the experiment started, and T2 and T4 are sampling cycles when the soil in the varying water regime treatment reached 30% water-filled pore space.

constant water regime as compared with variable water at 23°C (date not shown).

Phosphorus Plant Availability

The percentages of applied P fertilizer remaining plant available with time of incubation are given in Table 4. The increase in soil test P over the control at each sampling time was used to determine the amount of added P that was still plant available. The decrease or no change in soil test P over time indicated adsorption of added P by the soil to unavailable form.
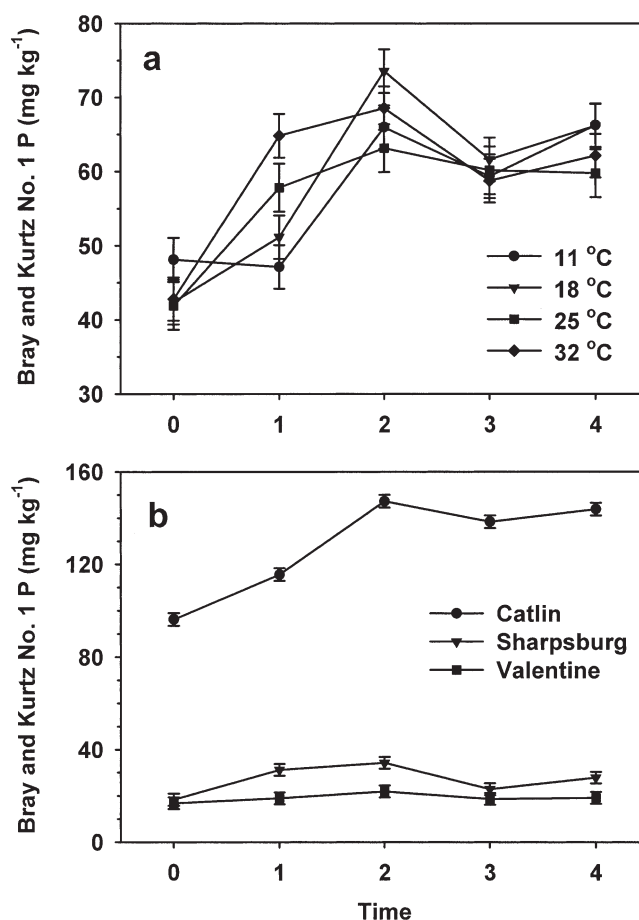

Fig. 4. Soil test P levels as influenced by (a) incubation temperature and sampling times and (b) soil and sampling time for the beef cattle feedlot manure study. Time T0 is when soil samples were taken on the day the experiment started, and T1 to T4 are sampling cycles when the soil in the varying water regime treatment reached 30% water-filled pore space.

At the low P application rate of 6 mg kg^{-1}, only 4 and 34% of the added P in the Catlin and Sharpsburg soils remained plant available by the end of the incubation period (T4), respectively. This application rate is equivalent to 12 kg P ha^{-1} (typical starter P application rate) if applied to the surface 15 cm soil and incorporated. If mixed well with the soil, only a small portion of the applied P at this low application rate will be plant available even shortly after application. In contrast, the percentage of applied P fertilizer remaining plant available in the Valentine soil by T4 of the incubation period was 73% at the low rate of 6 mg P kg^{-1} (Table 4). When P fertilizer application rate was increased to 68 mg kg^{-1}, which is similar to typical manure P application, more

Table 5. The percentages of applied manure P that became plant available in three soils following incubation for four wet–dry cycles.

Soil	Beef cattle feedlot manure				Swine slurry			
	T1†	T2	T3	T4	T1	T2	T3	T4
				%				
Catlin	46 ± 16‡	34 ± 9	70 ± 14	91 ± 34	37 ± 6	30 ± 8	44 ± 11	52 ± 10
Sharpsburg	94 ± 39	93 ± 30	108 ± 25	101 ± 18	62 ± 5	77 ± 9	74 ± 9	110 ± 12
Valentine	62 ± 11	58 ± 10	48 ± 10	60 ± 15	77 ± 3	69 ± 3	84 ± 4	77 ± 5

† Time T1 to T4 are sampling cycles when the soil in the varying water content treatment was reduced from 60 to 30% water-filled pore space.
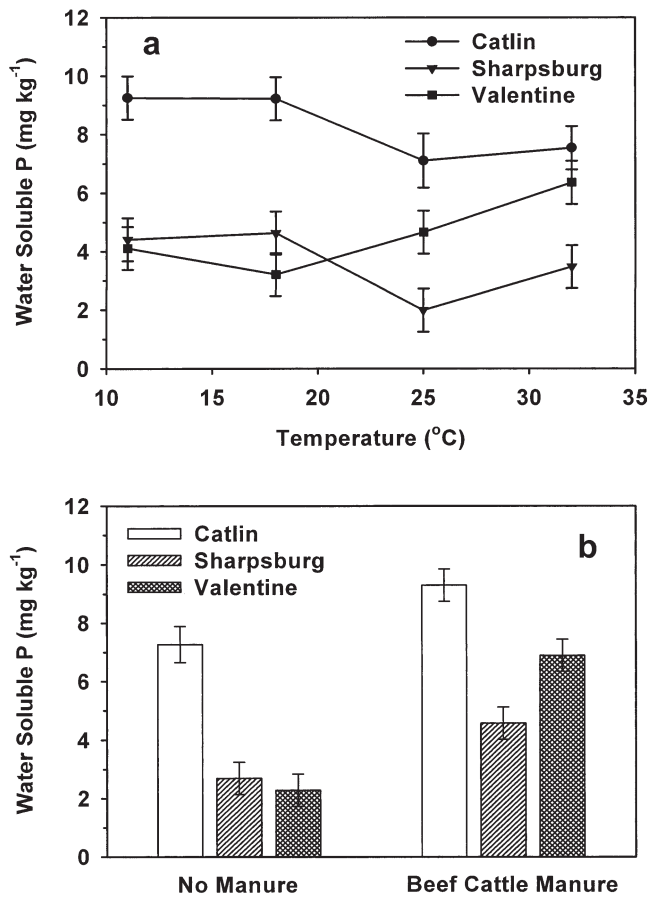‡ The values after ± are standard errors.

Fig. 5. Water-soluble P levels in three soils as influenced by (a) incubation temperature and (b) beef cattle feedlot manure and no-manure treatments.

than 61 and 79% of the applied P remained plant available in the Catlin and Valentine soils, respectively (Table 4). In the Sharpsburg soil, the fraction of applied P fertilizer remaining plant available decreased with time to 38% by the end of the incubation period (T4).

Phosphorus availability from beef cattle feedlot manure was high (>60%) for all three soils by the end of incubation period (Table 5). Eghball et al. (2002a) found that P availability from applied cattle feedlot manure was 85% in the first year after application in a field experiment. The values determined in the laboratory incubation are consistent with these field observations for the cattle feedlot manure. Phosphorus availability from swine slurry was also high (>52%) in all three soils. Averaged across soils and incubation times, P availability was 72% for beef cattle feedlot manure and 66% for the swine slurry. In P-deficient soils, P availability of about 70% can be used for either manure type.

The differences between the two manure types for P release and availability are due to the composition of P fractions in each manure type. While typically about 25% of the total P in beef cattle feedlot manure is organic (Eghball et al., 2002a), less than 10% of swine slurry P is organic (Sharpley and Moyer, 2000). Wienhold and Miller (2004) found about 60% of total P in swine slurry was in water-soluble form, and >80% of the WSP was inorganic. At T4 incubation time, P availability

was not significantly different between the manure types in each soil even though swine slurry had lower organic P than beef cattle feedlot manure. It seems that the inorganic fraction and most of the organic P in swine and cattle manure convert to plant available P form shortly after application. Variability of the availability values, as indicated by standard errors, were much lower for swine slurry than cattle manure, indicating better distribution of the liquid swine slurry in the soil than the solid cattle feedlot manure even though both manures were mixed thoroughly with the soil at the beginning of the incubation.

SUMMARY AND CONCLUSIONS

Temperature, soil moisture, soil properties, and manure characteristics influence the release of nutrients in manure. Phosphorus availability from beef cattle feedlot and swine slurry was 52 to 100% of total manure P with no significant difference between the two manure types in each soil. Phosphorus in manure can be used as an excellent P source for deficient soils. It seems that the high inorganic P fraction in manure (>70%) converts to plant available P in a short period after application. The P in manure can then be used similar to synthetic P fertilizer (100% available) in areas where P-based manure application is made to avoid soil P accumulation. In P-deficient areas, an estimation of about 70% availability from manure should be used. The amount of P available in the second, third, and fourth year after application can be determined by testing soil for available P. The high plant availability of manure P can increase the economic hauling distance for manure application. In some circumstances, it may be essential that P-based manure application be used to avoid excess P in runoff.

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